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BEADS OF METEORIC IRON FROM AN INDIAN
MOUND NEAR HAVANA, ILLINOIS

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by
ROBERT M. GROGAN
Illinois State Geological Survey

Reprinted from American Antiquity,
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BEADS OF METEORIC IRON FROM AN INDIAN MOUND NEAR HAVANA, ILLINOIS*

ROBERT M. GROGAN

IN the summer of 1945, members of the Illinois State Museum under the direction of Thorne Deuel, Director of the Museum, excavated a group of Indian burial mounds in the Havana, Mason County area. Burial No. 10 in Mound No. 9 of this group yielded 22 rounded bead-like objects, composed of strongly oxidized iron, together with slightly more than 1000 ground shell and pearl or pearl slug beads. As the burial was evidently prehistoric and of Hopewellian age, it was at once conjectured that the iron might be of meteoric origin. In January, 1946, several of these supposed iron beads were sent to the State Geological Survey, with the request that the nature and source of the iron be determined if possible. In addition, Dr. Deuel kindly made available the data presented herein on the nature of the discovery and on the size, shape, and arrangement of the supposed beads.

The material received consisted of two complete rounded specimens less than an inch in diameter, a sawed half of another, and a fragment of a fourth specimen, all of which were more or less strongly attracted by a magnet. A qualitative chemical analysis of a bit of metal broken from the fragment showed the presence of iron and nickel. The sawed half disclosed a hole extending most of the way through the center of that specimen, and two prominent pits on opposing sides of each of the two complete specimens strongly suggested that at one time a hole had pierced their centers.

Flat surfaces were ground on all four of the specimens so that their interiors could be studied. Plate XXVIII, *a* shows the appearance of a surface ground at right angles to the axis of the central hole through one of the specimens and then etched with dilute nitric acid. A zonal or concentric arrangement of the several parts of the specimen is apparent. At the center is a core of porous limonite, then a zone of dense limonite, next a semi-continuous band of gray metal, next a zone of dense limonite, and on the outside a shell of porous limonite enclosing a few sand grains. The metal consists of two kinds of iron, one of which appears light and the other dark where etched. The same zonal structure in a section of similar orientation but on another specimen is illustrated on Plate XXVIII, *b*.

Plate XXVIII, *c* shows a ground and etched surface oriented roughly parallel to the axis of the central hole through a specimen, but not so deeply cut as to intersect any part of the hole. Here the area occupied by the metal is much greater than in sections at right angles to

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the holes and there is no central core of limonite. This surface displays better than the others the laminated internal structure of the metal.

The appearance of a section cut through the center and parallel to the axis of the hole of a fourth specimen is shown in Plate XXVIII, *d*. The hole is lined with limonite, but still open for most of its length and filled with porous limonite in the remaining part.

The external appearance, the internal structure displayed in Pl. XXVIII, *a–d*, and data regarding the arrangement of the specimens in the burial permit certain deductions regarding the use and manner of fabrication of the specimens, all of which lead to the conclusion that they were hand-wrought metallic beads.

The small iron-bearing masses had cylindrical to flattened globular shapes and maximum transverse diameters of approximately 3/16 to 5/8 of an inch. Dr. Deuel and his associates first advanced the hypothesis that they were beads after observing that in the burial the metallic objects alternated with one or two disc-shaped, cut and ground shell beads and that their sizes varied in a manner indicating that all had been graded to size on a string.

Laboratory study substantiated this hypothesis by disclosing a hole remaining part way through one specimen and central cores of porous limonite marking the probable sites of central holes in two others. It also showed that the band of remaining metal has a conspicuous linear internal structure conforming in most places to the margin of the band, and also that the band seems to be made up of several flattened or gently curving segments connected by rather sharp bends except at one place (Pl. XXVIII, *b*) where the pattern of lamination in the metal and the limonite suggests that two edges or ends of the metal were brought together in a lap joint. This joint was the locus of a major alteration of metal to limonite. Limonite also has formed along apparent tension cracks in the sharp bends elsewhere. From the foregoing it seems most likely that the specimens were fabricated from sheets or strips of metal which were crudely worked into rough cylinders with a lapped seam along one side, thus forming beads.

The zonal arrangement of metal and limonite is explained in the following way: After their burial the beads were subjected to the action of soil water and began to rust. Rusting took place on the walls of the holes as well as on the exterior surfaces of the specimens, and produced the zones of dense limonite now found on either side of the remaining metal. The central core and the outer zone of porous limonite were probably formed by the deposition of iron hydroxide within the holes and also in the material surrounding the bead, which accounts for the sand grains found in the exterior portions of the specimens.

It has been mentioned that the metal consists of two kinds of iron as evidenced in the internal lamination brought out by etching. The metal in the dark laminae has been identified as largely alpha iron, and that in the light laminae as largely gamma iron.[1] As the iron is known to contain nickel, it is believed that the alpha iron may be properly called kamacite and the gamma iron, taenite, these being the mineralogical names for the alpha and gamma phases of the nickel-irons found in nature. In Plate XXVIII, *a–d*, the taenite laminae appear darker than those of kamacite, although actually the taenite is silvery white and the kamacite iron gray. This is because of the high reflectivity of the taenite coupled with the use of inclined rather than vertical illumination.

Various lines of evidence suggest that the iron is of meteoric origin. Supporting facts and the inferences based on them are summarized in the following paragraphs.

Steel containing nickel added by man was first introduced in 1890.[2] As the Havana iron is pre-Columbian it must therefore have come from some naturally occurring body of nickel-bearing native iron or have been smelted from an iron ore containing nickel. Native iron is of two types, meteoric and terrestrial or non-meteoric. Iron meteorites invariably contain nickel and are of widespread occurrence. Terrestrial iron is extremely rare and generally contains either very little or very much nickel. Also many iron meteorites exhibit the Widmanstätten structure discussed more fully below, the presence and character of which appears to depend upon the nickel content of the iron. It is said that the Widmanstätten structure appears only in those irons having between 6 and 14 per cent nickel.[3] The nickel content of known terrestrial irons is either above or below these limits, and hence no Widmanstätten structure is present. For example, the terrestrial iron found by drilling in Clinton, Hickory, and Holden counties, Missouri, contained no nickel,[4] and of 16 analyses of the Ovifak, Disco Island, Greenland terrestrial iron only one showed more than 3 per cent nickel,[5] whereas awaruite from New Zealand contained 67.63 per cent, souesite from British Columbia contained 76.48 per cent, and josephinite from Oregon contained 64.53 per cent nickel.[6] Although Steenstrup reported Widmanstätten figures in Greenland iron from two localities near the Disco Island occurrence,[7] the work of later investigators makes it likely that a microstructure featuring an intergrowth of ferrite (alpha iron) and cementite (iron carbide) was mistaken by Steenstrup for Widmanstätten structure.[8] Supporting evidence is the low nickel content, 0.34 and 2.55 per cent, found by Lorenzen[9] in iron from the two localities described by Steenstrup. Iron ores containing an appreciable quantity of nickel are also very rare, two occurrences being in Cuba and the Netherlands Indies.[10] The Cuban ores contain 0.55 to 0.8 per cent nickel, which with a concentration of 3 to 1 by smelting would yield an iron with only about 2.5 per cent nickel.[11] Furthermore, it is unlikely either that nickeliferous Cuban iron ore would have found its way to the Hopewellian people or their contemporaries, or that they had the knowledge to smelt the ore. It therefore appears most likely that the Havana iron was derived from a meteoritic source.

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[1] H. L. Walker, Professor and Head, Department of Mining and Metallurgical Engineering, University of Illinois, personal communication.

[2] T. A. Rickard, *Man and Metals*, Vol. 2, p. 845, New York: The Whittlesey House, 1932.

[3] S. H. Perry, "The Metallography of Meteoric Iron," *Bulletin, U. S. National Museum*, No. 184, p. 46, Washington, 1944.

The Widmanstätten structure mentioned above is characteristic of the common octahedrite variety of iron meteorites (Pl. XXVIII, *e*). The structure consists of plates of kamacite with taenite selvages arranged along regular octahedral crystallographic planes. The angular interstices between these plates are usually occupied by plessite, which is an intimate intergrowth of kamacite and taenite.

An analogous situation is found in the specimens from Havana, in that there are present laminae of taenite and laminae consisting principally of kamacite. At high magnification it is seen that the kamacite laminae exhibit a relict granularity in which the former boundaries of the kamacite crystals are marked by chains of tiny droplike particles of taenite. Because of the abundance of taenite, these laminae more closely resemble in composition the intimate mixture of kamacite and taenite, known as plessite in meteorites, than they do the ordinary kamacite laminae. Actually, pure kamacite without any intergrown taenite is almost lacking.

The laminae in the Havana specimens show, however, no regular structural arrangement in the octahedral pattern with the possible exception of the rectangular area of taenite crossed diagonally by a band of kamacite present near one outside edge of the specimen illustrated on Plate XXVIII, *d*. Nevertheless, it is considered probable that the arrangement of the laminae in the Havana iron may represent the original Widmanstätten structure present in the parent meteoric iron, now rearranged and partially obliterated as the consequence of cold

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[4] E. T. Allen, "Native Iron in Coal Measures in Missouri," *American Journal of Science*, 4th Series, Vol. 4, pp. 99–104, New Haven, 1897.

[5] J. D. Buddhue, "Native Iron and its Alloys," *The Mineralogist*, Vol. 4, No. 5, pp. 3–4, 29–35, 1936.

[6] J. D. Buddhue, *idem*.

[7] K. J. V. Steenstrup, "On the Occurrence of Nickel-iron with Widmanstätten's Figures in the Basalt of North Greenland," *Mineralogical Magazine*, Vol. 6, pp. 1–13, 1884.

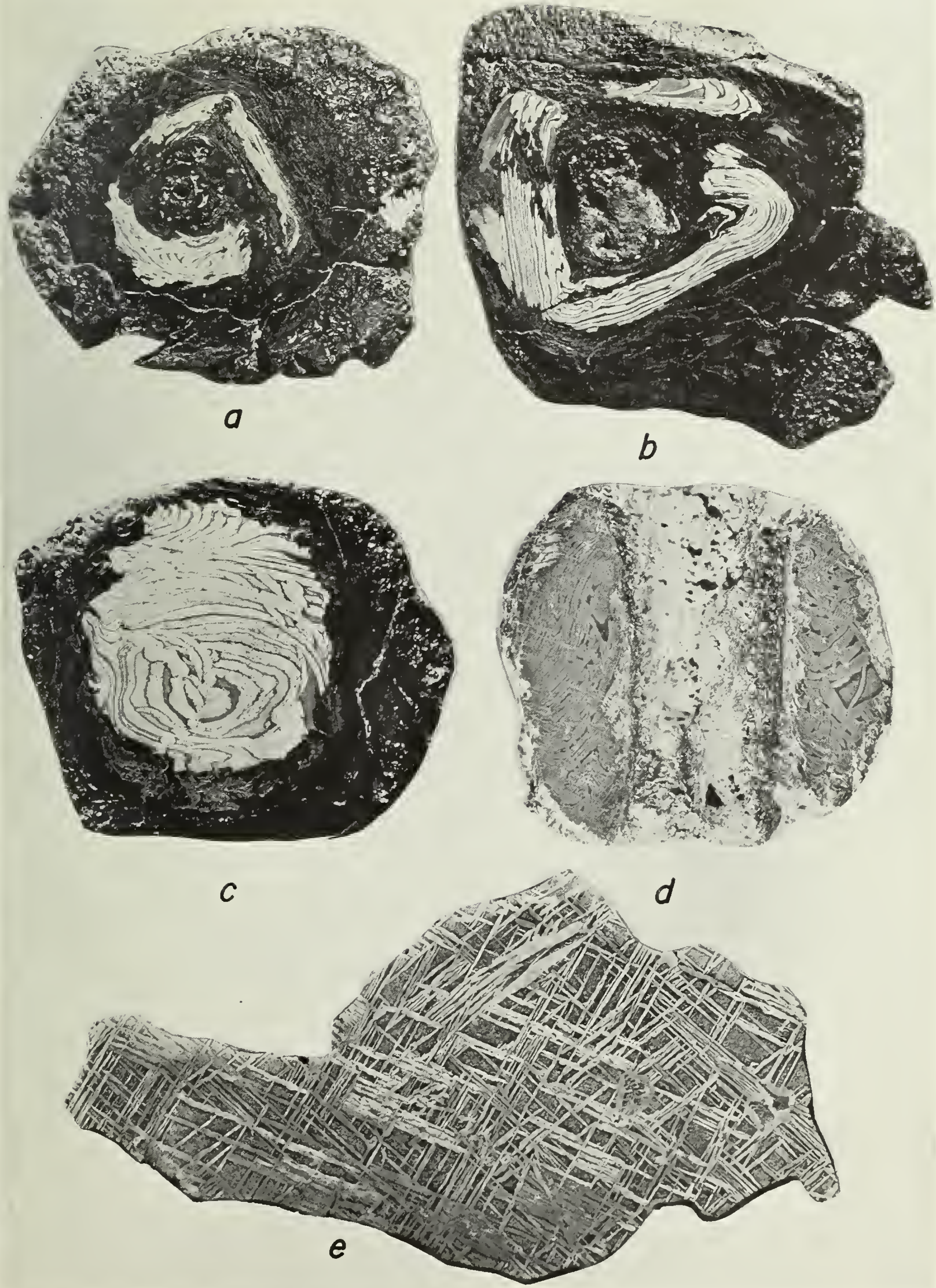
[8] See Sir H. Carpenter, "Native Iron from West Greenland," *Nature*, Vol. 136, No. 3430, pp. 152–3, 1935.

[9] J. Lorenzen, "A Chemical Examination of Greenland Telluric Iron," *Mineralogical Magazine*, Vol. 6, pp. 14–38, 1884.

[10] T. A. Rickard, *Man and Metals*, Vol. 1, p. 170, New York: The Whittlesey House, 1932.

[11] T. A. Rickard, *op. cit.*, Vol. 2, p. 846.

Explanation of Plate XXVIII. *a*, polished and etched section through first bead, cut transverse to axis of central hole; metal portion light gray, alteration products dark; long dimension of specimen about one inch. *b*, transverse section of second bead, polished and etched; metal light gray, oxides dark; note parallel lamination in metal and arrangement of straight-sided segments connected by sharp bends; longest dimension of specimen about one inch. *c*, tangential section of bead, cut approximately parallel to the axis of the central hole, polished and etched; note random pattern of lamination; long dimension of specimen about three-quarters of an inch. *d*, section of bead cut along the axis of the central hole; boundaries of hole are distinct even though the hole is partly filled with porous limonite. *e*, undistorted octahedral structure in the Thurlow meteorite; lath-like areas of kamacite and taenite border rectangular "fields" of plessite. Photographs *a–d* by L. D. Vaughn; photograph *e* courtesy of E. P. Henderson, U. S. National Museum.)



Sections through iron beads from a mound near Havana, Illinois and through a meteorite. (See facing page for identifications.)

working of the metal by man.

In the working of the metal to shape it into cylinders any original metallic structure would have suffered a considerable amount of deformation. Such deformation actually is evidenced by the stretched-out pattern of the taenite and the kamacite laminae and also by a unidirectional flattening of the original kamacite grains shown at many places by the taenite particles which marked the former kamacite grain boundaries. In spite of this, however, at magnifications of 800 to 900 diameters, it may be seen that the kamacite is now made up of tiny, undeformed, approximately equiaxial crystals. In Professor Walker's opinion[12] this indicates a recrystallization of the kamacite resulting from a mild heat treatment subsequent to the forming of the metal into the bead shapes. Such a heat treatment might have been attained by a mild heating in a campfire or altar fire for a period of no longer than 30 minutes.

The work of many investigators has demonstrated many instances of the fabrication of meteoric iron into ornamental or useful objects by primitive peoples. An excellent summary of the available data has been given by Zimmer.[13] Predynastic Egyptian iron beads containing 7.5 per cent nickel[14] were tubular in construction and were apparently made by cold bending a flat strip of the metal.[15] Eskimos used knives whose cutting edges were composed of flakes of meteoric iron set in a groove in walrus bone. Peary found that the iron was obtained from a large meteorite. The Eskimos pounded the meteorite with stones until small ridges of metal were formed, which could be detached in the form of flakes for use.[16] Most important of all because of their cultural relations with the Havana mound builders, the peoples who constructed the Porter, Hopewell, Turner, and Liberty groups of mounds in Ohio fabricated numerous ornamental objects of meteoric iron as well as of copper, silver, and gold.[17] The meteoric iron was found as nuggets and worked into headplates, breastplates, beads, coverings for ear-plugs, adze blades, chisels, and drills. In several of its applications it was necessary that the iron be pounded into flat plates, and it is apparent from some of the objects made that these people well understood the technique of fabricating cylindrical objects from flat strips of metal. Many of the objects from the Ohio mounds were found on altars and had evidently suffered some effects of heat. Kinnicut[18] reported that one irregular cubical mass of heavily oxidized iron from the Turner mounds analyzed 86.66 per cent iron and 12.67 per cent nickel and showed well-marked Widmanstätten figures.

On the basis, therefore, of the nickel content of the iron in the Havana beads, its prehistoric age, the presence of relict Widmanstätten structure, the rarity and chemical dissimilarity of terrestrial irons, and the fact that primitive peoples of both similar and dissimilar cultures are known to have made use of meteoric iron for useful and ornamental objects, it is concluded that the Havana iron is of meteoric origin.

State Geological Survey
Urbana, Illinois
September, 1947

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[12] Personal communication.

[13] G. F. Zimmer, "The Use of Meteoric Iron by Primitive Man," *Journal of the Iron and Steel Institute*, Vol. 94, pp. 306–49, 1916.

[14] Rickard, *op. cit.*, Vol. 2, p. 864.

[15] Rickard (*op. cit.*, Vol. 1, p. 146) makes reference to G. A. Wainwright, "Iron in Ancient Egypt," *Cairo Scientific Journal*, August, 1914.

[16] Rickard, *op. cit.*, Vol. 1, pp. 140–1.

[17] F. W. Putnam, *Peabody Museum of American Archeology and Ethnology Reports*, Vol. 3 (16th and 17th Annual Reports), pp. 171–3, Cambridge, 1880–86.

F. W. Putnam, *American Anthropologist*, O.S., Vol. 5, p. 49, Washington. 1903.

C. C. Willoughby, "Primitive Metal Working," *American Anthropologist*, O.S., Vol. 5, p. 55, Washington, 1903.

C. C. Willoughby, "The Art of the Great Earthwork Builders of Ohio," *Annual Report of the Smithsonian Institution*, 1916, pp. 492–5, Washington, 1917.

[18] L. P. Kinnicut, "Report on the Meteoric Iron from the Altar Mounds in the Little Miami Valley, Ohio," *Peabody Museum of American Archeology and Ethnology Reports*, Vol. 3 (16th and 17th Annual Reports), pp. 381–4, Cambridge, 1880–86.

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